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Keith K. Knapp

Iowa State University, kknapp@iastate.edu

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RESEARCH PROJECT TITLE

Evaluation of Pavement Markings on Low-Volume Rural Roadways in Iowa

SPONSORS

Iowa Department of Transportation
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PRINCIPAL INVESTIGATOR

Keith Knapp, Director
Iowa Local Technical Assistance Program
Institute for Transportation
Iowa State University
515-294-8817
kknapp@iastate.edu

MORE INFORMATION

www.intrans.iastate.edu

**Institute for Transportation
Iowa State University
2711 S. Loop Drive, Suite 4700
Ames, IA 50010-8664
515-294-8103**

The mission of the Institute for Transportation (InTrans) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

The Iowa Local Technical Assistance Program (LTAP) is dedicated to providing technical and management assistance to Iowa's local governments through a variety of programs and resources.

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Evaluation of Pavement Markings on Low-Volume Rural Roadways in Iowa

tech transfer summary

An investigation of pavement-marking standards and practices on low-volume roads can provide local agencies with useful information for pavement-marking decision-making.

Background and Problem Statement

It has been common practice for most Iowa counties to enhance paved and/or seal-coated roadways with pavement markings (e.g., a yellow centerline, white edgelines, or both). However, the current *Manual on Uniform Traffic Control Devices (MUTCD)* requires centerline and/or edgeline pavement markings only along streets and roadways with volumes much higher than 400 vehicles per day (vpd).

The *MUTCD* defines the following standards used to install and maintain traffic control devices on all roadways open to public travel and applies to the determination and use of traffic control devices, including pavement markings, within Iowa:

- Section 5E.02 of the *MUTCD* focuses on centerline pavement markings and states that they “should be used on paved low-volume roads consistent with the principles of this Manual and with the policies and practices of the road agency and on the basis of either an engineering study or the application of engineering judgment.”
- Section 5E.03 describes edgeline pavement-marking applications and states that they “should be considered for use on paved low-volume roads based on engineering judgment or an engineering study.”
- Section 3B.01 discusses yellow centerline pavement markings and warrants and states that they “should also be placed on all rural arterials and collectors that have a traveled way of 18 feet or more in width and an [average daily traffic] ADT [volume] of 3,000 vehicles per day or greater. Centerline markings should also be placed on other traveled ways where an engineering study indicates such a need.”
- Section 3B.07 discusses edgelines and states that they “shall be placed on rural arterials with a traveled way width of 20 feet or more and an ADT of 6,000 vpd.”

Project Objective

The objective of this project is to provide local agencies with information that might be useful to their low-volume roadway pavement-marking decision-making.

Research Description

This work included a review of past pavement-marking research, a survey of Iowa county engineers that focused on their current pavement-marking practices, and a basic benefit-cost evaluation.

The cost of installing and maintaining pavement markings was also documented, and an opinion on the legal implications related to pavement markings was obtained.

The literature review examined the safety- and operational-related impacts of centerlines and/or edgelines along roadways, with a specific focus on low-volume roadways. This literature included work from Kentucky, Louisiana, Pennsylvania, Texas, and Virginia. Literature related to pavement-marking costs and removal was also reviewed.

A legal opinion on the use and maintenance of pavement markings was also requested as part of this project. The researchers approached the Iowa State Association of Counties (ISAC), which obtained an opinion from the Iowa Communities Assurance Pool (ICAP). A letter was then prepared by a staff member from a firm in Council Bluffs.

A survey focused on pavement-marking use, maintenance, and costs was provided to all Iowa County Engineers in 2014, with 37 of the 99 counties responding.



Responses to the pavement-marking survey showed that most of the paved secondary roadways in Iowa have both centerline and edgeline pavement markings as opposed to centerline/no passing zone only (Image: Bob Sperry, retired from Iowa LTAP)

An exploratory analysis of pavement-marking benefits and costs was completed for a hypothetical one-mile segment of secondary roadway to determine the percent total crash reduction required to produce a benefit-cost ratio of 1.0. This calculation was completed for paved and seal-coated roadways with either centerline/no passing zone (NPZ) only or centerline/NPZ and edgeline marking configurations.

Key Findings

- The standard or required pavement-marking information provided in the *MUTCD* generally applies to facilities other than low-volume (400 vpd or less) roadways. The decision to install pavement markings along low-volume roadways is currently based on engineering studies and/or judgment.
- Several other documents provided additional pavement-marking application guidance. In one case, the remaining pavement service life is used to determine the time for pavement-marking replacement and recommend the type of pavement marking to apply. In another case, the roadway's function is used to determine the pavement markings to place and the replacement frequency. A study in South Carolina recommends waterborne pavement markings for roadways with less than 1,000 vpd.
- The literature review yielded limited results for low-volume roadways, but projects from several states were reviewed. These projects had a wide range of robustness and results.
- An edgeline analysis on rural narrow roadways in Louisiana showed mixed results in terms of vehicle position due to edgelines, but a safety analysis indicated a 15 percent reduction in total crashes. On the other hand, the pavement-marking study referenced in the *Highway Safety Manual (HSM)* indicates that adding centerlines may or may not impact injury or property-damage-only crashes. In fact, the *HSM* recommends that the crash modification factors (CMFs) it includes for centerlines be used with caution. The study the *HSM* includes for applying a combination of centerline and edgelines, however, shows a 24 percent reduction in injury crashes.
- The legal opinion solicited does not appear to add to the general knowledge. The opinion generally summarized the factors regarding local immunity in Iowa and also indicated that traffic control devices, once installed, are required to be maintained.

- Based on the responses to the pavement-marking survey, it appears that the majority of the paved secondary roadways in Iowa have both centerline and edgeline pavement markings. Seal-coated secondary roadways, on the other hand, if they exist in a county, might have a centerline/NPZ, a combination of centerline/NPZ and edgeline pavement markings, or no pavement markings.
- According to the survey, the most common replacement interval for pavement markings is one or two years, and the typical cost per station (100 feet) appears to range from approximately \$3.00 per station to about \$6.00 per station (for an individual centerline or edgeline marking).
- The benefit-cost safety evaluation revealed that the total crash reductions due to pavement markings do not need to be very large to produce benefits that are greater than their cost. The overall crash reductions needed ranged from 0.42 percent to 5.1 percent, depending on the combination of markings used. These reductions are within the range of safety impact study results found in the literature review.

Recommendations and Future Research

- While a gap exists in the knowledge regarding the safety impacts of pavement markings, the costs associated with installing and/or removing pavement markings on low-volume roadways has increased the need for this information. Therefore, it is recommended that the safety impacts due to the installation of centerline/NPZ or centerline/NPZ and edgelines on both high- and low-volume roadways be further evaluated. More reliable and robust CMFs are needed related to the installation of basic pavement markings.
- The development of a secondary roadway pavement-marking database is recommended. This database could include additional information about pavement-marking costs and other potentially valuable characteristics. This information could be part of a pavement-marking asset management program.
- The legal opinion provided regarding traffic control devices is generally common knowledge to Iowa counties. It is recommended that a committee be created to develop sample policies related to pavement-marking removal procedures. It is also recommended that this committee include a county attorney to provide legal advice on the policy.

- The *MUTCD* provides some guidance about the removal of traffic signals, and previous research from the Institute for Transportation (InTrans) has addressed stop sign removal. It is recommended that this information, and the input from the committee, be used to develop policy content related to pavement-marking removal (e.g., a staged approach including, among other things, the use of engineering judgment/study, informing the public, staged traffic control, and observation/monitoring).

Implementation Readiness

Most Iowa counties commonly enhance paved and/or seal-coated roadways with pavement markings (e.g., a yellow centerline and/or white edgelines). The decision to install pavement markings is currently based on engineering studies and/or judgment.

Implementation Benefits

Further study of the safety impacts of installing pavement markings can provide local agencies with useful information for pavement-marking decision-making.

The benefits of pavement markings are not completely described by the benefit-cost safety evaluation, in that pavement markings benefit driver behavior and other factors. The evaluation, however, shows the low level of total crash reductions that would be needed, on average, to make pavement markings beneficial.

The development of a secondary roadway pavement-marking database would help evaluate pavement-marking installation procedures, maintenance costs, and potential safety impacts.

References

- AASHTO. *Highway Safety Manual (HSM)*. 1st Edition. American Association of State Highway Officials, Washington, DC, 2010.
- FHWA. *Manual on Uniform Traffic Control Devices*. 2009 Edition. Federal Highway Administration, U.S. Department of Transportation, Washington, DC, 2009.